REMARKS

This response is submitted to the Office Action mailed October 28, 2004, in the subject patent application.

Reconsideration is respectfully requested for claims 1-14 in view of the following remarks.

The Examiner notes that claims 6 and 7 would be allowable if rewritten in independent form include all limitations of the base claims and any intervening claims.

Claim 15 has been provisionally rejected under 35 USC 101 for double patenting. Claim 15 is now cancelled.

Reconsideration is respectfully requested for claims 1-5 and 8-14.

Claims 1, 3-5, 8, and 10-14 have been rejected under 35 USC 102(e) as being anticipated by Burton et al., U.S. Patent No. 6,531,721. The Examiner refers to the structure of Fig. 3 and to the collector region 330 of one conductivity type (n) abutting the base region (312) the collector comprising at least 3 layers having decreasing dopant concentrations toward the base regions (Column 6, lines 15-35), the layer in the collector region (336) abutting the base region (312) allegedly having the lowest dopant concentrations (2 X 10^{16}-CM^2) (Column 6, lines 27-29). The Examiner further refers to the collector region having a non-uniform doping and allegedly having the lightest doping (2 X 10^{16}-CM^2) (Column 6, lines 27-29) near the base region (312) and heaviest doping (5 X 10^{16}-CM^2) (Column 6, lines 22-24) near the subcollector region (310), the heaviest doping being less than the doping (5 X 10^{18}-CM^2) (Column 6, lines 15-18) in the subcollector region.

This rejection is respectfully traversed. While Burton et al. do disclose a heterojunction bipolar transistor in Figure 3 which has three layers in the collector, the lowest doping is the middle layer (334) and not the layer abutting the base region as specified in independent claims 1 and 8.

Burton et al. specifically teach placing a medium/low doped collector region 336, with doping higher than the doping of middle layer 334, directly beneath base 312 to prevent base push out, or the "Kirk" effect. See column 6, lines 52-54. This is contrary to the claimed invention. Burton et al. go on to describe that base push out occurs when the collector current rises to a level where the number of electrons entering the depletion region exceeds the background doping level. When the electrons exceed the back ground doping level, the result is the depletion region is pushed out into the collector, increasing the base width. Ultimately, base push out leads to a decrease in current gain. Burton et al. further state that by situating medium/low doped collector layer 336 immediately beneath base 312, i.e. at the collector-base junction, and by controlling the doping profile of medium/low doped collector layer 336, the electric filed at the collector-base junction is modified and base push out can be prevented.

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The use of higher doping in layer 336 abutting the base region can be further appreciated by comparing the structure of Figure 2, without the medium/low doped collector layer 336, and Figure 3 which is the same as Figure 2 but includes medium/low doped collector layer 226.

As noted above and in column 6, lines 52 etc, the purpose of having medium/low doped collector layer directly beneath base 312 is to prevent base push out, or the "Kirk" effect. Base push out occurs when the collector current rises to a level where the number of electrons entering the depletion region exceed the background doping level. Therefore, Burton et al. <u>increase</u> the background doping level at the base surface by providing medium/low doped collector layer 336 which has higher doping than the low doped collector layer 334. By providing increased doping in the layer abutting the base region 212, the background doping level is increased and base push out can be prevented.

While Burton et al. do describe doping ranges for low doped layer 234(1×10^{16}-3×10^{16}) and the medium/low doped layer 336 (2×10^{16}- 5×10^{16}) the clear teaching of Burton et al. is that the medium/low doped collector layer 336 has <u>higher</u> doping than low doped layer 234 to thereby provide a <u>higher</u> background doping level abutting the base region and thereby preventing the number of electrons entering the depletion region from exceeding the background doping level (e.g. doping of layer 336) and prevent base push out.

Accordingly, it is respectfully submitted that the clear teaching of Burton et al. with regard to structure of Fig. 3 is to provide increased doping in collector layer 336 abutting base 312 relative to the low doped collector layer 334 which is provided between the medium/low doped layer 336 and the medium doped collector layer 332. This is not in accord with the claimed heterojunction bipolar transistor defined by claims 1 and 8 wherein the layer in the collector abutting the base region has the lowest dopant concentration. The teachings of Burton et al. are completely contrary to the claimed invention.

While placing a medium/high doped collector layer abutting the base can help reduce the base push out effect, as taught by Burton et al., it can also present another problem: at lower V_{ce} the electric field in the low doped collector layer in the middle of the collector could reverse direction and trap electrons. This will degrade the transistor performances in RF operation.

Accordingly, it is respectfully submitted that the heterojunction bipolar transistor as defined by claims 1, 3-5, 8 and 10-14 is neither shown nor suggested by the teachings of Burton et al.

Claims 2 and 9 have been rejected under 35 USC 103(a) as being unpatentable over Burton et al. as applied to claims 1, 3-5, 8, 10-14 and further in view Luryi U.S. Patent No. 5,496,743. The Examiner notes that Burton et al. do not disclose that the layer in the collector region abutting the base region is thicker than the other two or more layers in the collector region. The Examiner refers to Luryi as disclosing a composite (solid material collector of more than two constituents) wherein the n+ layer abutting the base is thicker than the other layer

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(n++). The Examiner concludes that it would have been obvious to combine the layer structure of Luryi with Burton et al. to obtain a HBT with higher breakdown voltages.

This rejection is respectfully traversed. As noted above, Burton et al. do not show a heterojunction bipolar transistor having a collector region comprising at least three layers with decreasing dopant concentrations toward the base, the layer in the collector region abutting the base having the lowest dopant concentration. The base/collector composite of the Luryi transistor structure is not believed relevant nor is the collector up inverted structure or the active packaging of Luryi relevant. Accordingly, it is respectfully believed that dependent claims 2 and 9 are neither shown nor suggested by Burton et al. alone or taken with Luryi.

Since the Examiner has indicated that claims 6 and 7 would be patentable if amended, since claims 1, 3-5, 8 and 10-14 are patentable under 35 USC 102(e) and 103 over Burton et al., and since claims 2 and 9 are patentable under 35 USC 103(a) over Burton et al. in view of Luryi, all as above set forth, it is requested that claims 1-14 be allowed and the case advanced to issue.

Should the Examiner have any questions or comments concerning the present amendment and response, a telephone call to the undersigned attorney (650-314-5311) is requested.

Respectfully submitted,
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